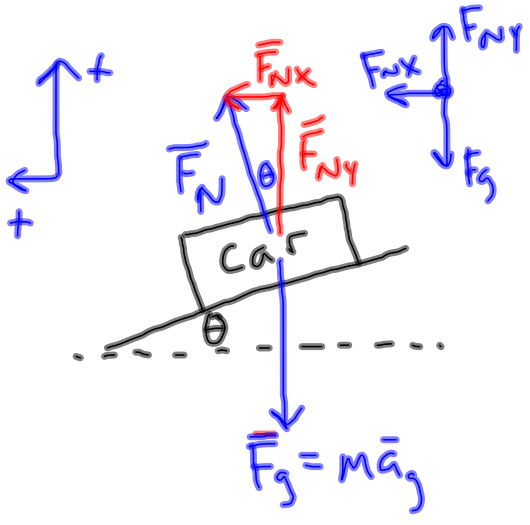
HW: p. 155: 1, 3, 5

p. 156: 9

Lab due 10/20 (Thursday)

A civil engineer wishes to redesign the curved roadway in the previous example in such a way that a car will not have to rely on friction to round the curve without skidding. In other words, a car moving at the designated speed can negotiate the curve even when the road is covered with ice. Such a ramp is usually banked, which means that the roadway is tilted toward the inside of the curve. Suppose the designated speed for the ramp is to be 13.4 m/s (30.0 mph) and the radius of curvature is 35.0 m. At what angle should the curve be banked?



$r = 35$ m

$v = 13.4$ m/s

$m = 1500$ kg

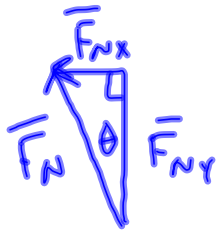
$\Sigma \bar{F}_x = m\bar{a}_c$

$F_{Nx} = m\frac{v^2}{r}$

$\Sigma \bar{F}_y = 0$

$F_{Ny} - F_g = 0$

$F_{Ny} = F_g = ma_g$



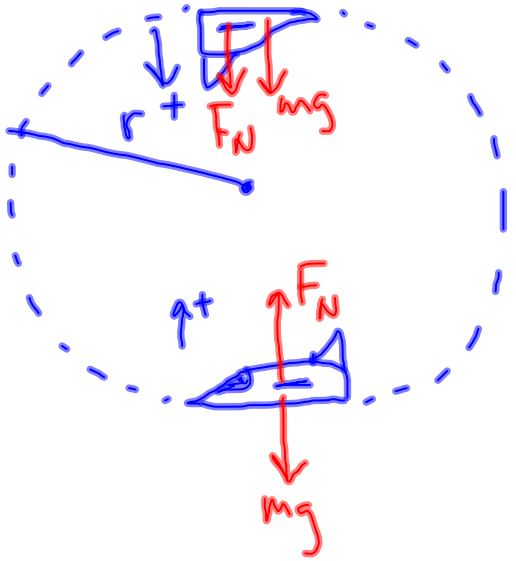
$$\tan\theta = \frac{F_{Nx}}{F_{Ny}}$$

$$\theta = \tan^{-1}\left(\frac{F_{Nx}}{F_{Ny}}\right) = \tan^{-1}\left(\frac{m\frac{v^2}{r}}{ma_g}\right)$$

$$= \tan^{-1}\left(\frac{v^2}{a_g r}\right)$$

$$= 27.6^\circ$$

A pilot of mass m in a jet aircraft executes a loop-the-loop maneuver. In this maneuver, the aircraft moves in a vertical circle of radius 2.70 km at a constant speed of 225 m/s.
a) Determine the force exerted by the seat on the pilot at the bottom of the loop. Express your answer in terms of the weight of the pilot mg.
b) Determine the force exerted by the seat on the pilot at the top of the loop, again in terms of mg.



a) $\Sigma \vec{F}_r = m\vec{a}_c$

$F_N - mg = \frac{mv^2}{r}$

$F_N = mg + \frac{mv^2}{r}$

$= mg\left(1 + \frac{v^2}{rg}\right)$

$= mg\left(1 + \frac{(225\ m/s)^2}{(2700\ m)(9.8\ m/s^2)}\right)$

$= (2.91)mg$

b) $\Sigma \vec{F}_r = m\vec{a}_c$

$F_N + mg = m\frac{v^2}{r}$

$F_N = \frac{mv^2}{r} - mg$

$= mg\left(\frac{v^2}{rg} - 1\right)$

$= mg\left[\frac{(225\ m/s)^2}{(2700\ m)(9.8\ m/s^2)} - 1\right]$

$= (0.91)mg$